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Published in:
Scientific Proceedings

Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

PO.472

Innovative Concepts of Wind Turbine Blade Design

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Abstract

In this project a concept blade is designed by Risø DTU. A new design philosophy has resulted in not only a better structural performance but also a light weight blade. The concept blade represents remarkable weight and cost reductions.

Innovative Reinforcements Prevent Failure

The extensive testing and numerical simulation which Risø DTU has performed, has resulted in considerable knowledge about structural failure mechanisms of wind turbine blades. “New” failure modes have been addressed which open up for a new optimized blade with extra reliability. Risø DTU has patented 7 innovative structural solutions during the last 5 years. The box girder design presented here includes 3 of 7 patented solutions.

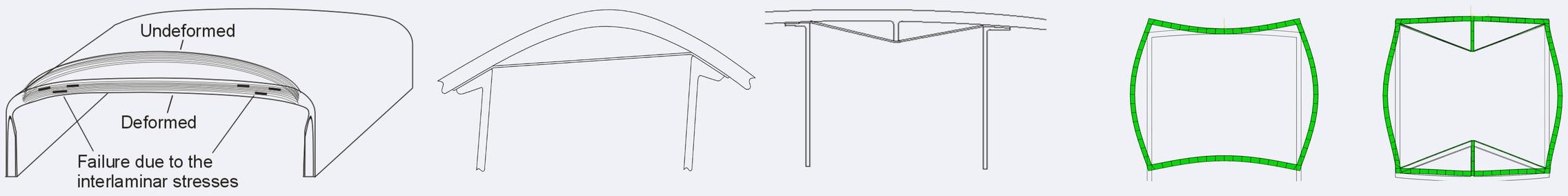

Figure 1. *a) Delamination failure in load carrying laminate b+c) Two different solutions reducing the delamination problem. d+e) FEM-simulations show the effect of transverse stiffeners.*

A combination of numerical and experimental work has been used to address the most critical failure mechanisms, e.g. interlaminar failure in the load carrying laminates, see **Figure 1a**. This failure mechanism is caused by a nonlinear force (Brazier loads) which is expected to be dominant in many existing and future blade designs. The inwards deformations must be minimized to avoid interlaminar failure, and one solution is to insert a transverse stiffener from the two web corners, see **Figure 1b+c**. By the use of these inventions the thickness of the load carrying laminates is reduced by 40%.

Furthermore, the blade is prevented from distorting in transverse direction, see **Figure 2**.

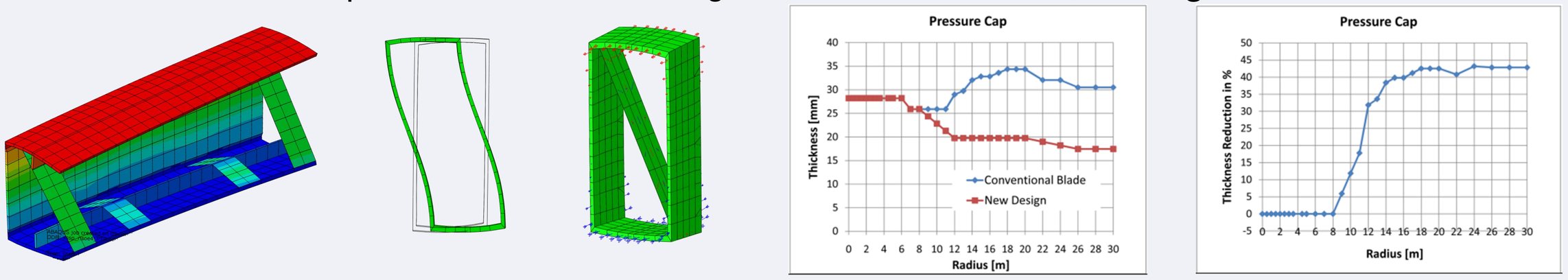

Figure 2. *FEM-studies show a reduction of the load carrying laminate at 40% and the shear distortion is reduced using Risø DTU’ inventions*.

Manufacturing

As a proof of concept, a load carrying box girder has been manufactured by SSP Technology A/S, to demonstrate the use of the patented solutions on a real blade .

Figure 3. *The box girder manufactured by SSP-Technology will be tested at Risø DTU’s full-scale test facility in spring 2011*

Future work

The load carrying box girder will be tested at Risø DTU’s new full-scale research test facility in order to demonstrate the effect of the new innovative design philosophy.

http://structuralbladedesign.risoe.dtu.dk

The research is supported by Danish Energy Agency through the Energy Technology Development and Demonstrations Programme EUDP
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